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A SCANNING DEVICE

THIS INVENTION concerns a scanning device, particularly, though not exclusively, to enable rapid and positive examination of pipework to locate and quantify any internal corrosion or damage resulting in loss of wall thickness.

The invention has a particular application in the safety inspection of pipework in chemical plant; in maritime applications such as ships used to carry oil or other liquids, and on oil production platforms where pressurised liquids are transported through pipes.

In such applications legislation requires that operators regularly monitor the physical conditions of pipework for early detection of deterioration, and pipes are often located in positions of difficult access.

A system is required particularly to provide a first check so that defective pipework may be marked and subsequently further scrutinised using equipment of, perhaps, greater accuracy and scope. Traditionally, pipe wall integrity has been inspected using complex assemblies of sensors with mechanical devices to maintain the sensors in contact with the external pipe wall and to manoeuvre the sensors along the wall in a scanning motion. In the sometimes harsh environment in which such devices must be used, the provision of delicate mechanical mechanisms is undesirable, and it is difficult to be sure that adequate contact is maintained between the sensors and

the pipe surface.

To provide a device whereby an operator may rapidly inspect large areas of pipework for apparent defects, there is provided, according to the present invention, a scanning device adapted to produce an electrical signal representative of a physical characteristic of a substrate with which the device is placed in contact, and comprising a flexible carrier, at least one sensor mounted on the carrier and including means to produce said electrical signal, and means for mounting the carrier on an operator's hand such that manipulation of the hand and thus the flexible carrier may ensure positive contact between the carrier and the substrate. Preferably, the device is provided in the form of a glove, across the inner surface of the fingers of which there is attached a flexible pad, preferably of rubber or neoprene, for example, to which there is attached an array of ultrasonic sensors or probes, each connected to a junction box strapped to the outer surface of the glove and including a visual/audible alarm, and an electrical lead to transmit signals to a remote monitor.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a schematic illustration of a scanning device made in accordance with the invention;

and Fig. 2 is a block circuit electrical diagram illustrating the principal features of the device and connected to a digital detector unit having a screen to provide a read-out representing the signals received from the scanning device.

Referring now to the drawings, in Fig. 1 there is shown a right-hand, plastics-coated glove 10 to which is attached across the front face of the fingers a rubber or other flexible material pad 11. Embedded in the pad 11 is an array of four ultra-sonic sensors or probes 12, each adjacent pair being spaced apart by approximately 33mm thus to provide an overall scan width in the region of 100mm. The probes 12 are connected by respective leads 13 to an 8:2 junction box 14 the output of which is connected via a lead 15 to a remote ultra-sonic detection unit 22 (see Fig. 2).

The junction box 14 is attached to the glove 10 by strapping 16, and includes a visual alarm in the form of an LED 17 and, if required, an audible alarm in the form of an internal buzzer which may alternatively feed the audible signal to headphones (not shown) connected to the junction box 14 by a further lead.

The scanning device illustrated in Fig. 1 can be flexibly deformed to conform to the shape of a pipe and provide a circumferential coverage of around 100mm in one pass along a pipe wall while closely wrapped around the pipe circumference to provide firm and positive contact and uniform reading from each probe 12.

Referring now to Fig. 2, the device is illustrated under

test conditions in which the ultra-sonic probes 12 are illustrated as being effectively in contact with a flat substrate in the form of a test piece 20 having an area of reduced wall thickness as illustrated at 21, representing, perhaps, an area of corrosion.

Each probe contains a pair of emitters which together emit a signal which passes through the test piece to the "back wall" thereof and is reflected back to the probe so that the time period until receipt of the reflected signal provides a reading representing the instantaneous thickness of substrate material. Signals from all four probes are transmitted simultaneously to the digital flaw detector unit 22. The unit 22 is calibrated to provide on a screen 23 an image representative of the signals from the four probes, any reduced thickness in the test piece or substrate being depicted on the screen at a shorter time period than the signal from the "back wall". This information can be recorded within the detector 22, and made to trigger the audible and visual alarms on the glove.

In use, the operator will pass the scanning device over a surface to be inspected and in the event of a defect such as is illustrated at 21 the alarm LED will be illuminated and, if included, the audible signal will sound. Thus the operator will be alerted to a defect and will mark the location on the pipe and move on to inspect the remainder of the substrate surface. Subsequently, manual equipment providing perhaps, more comprehensive or specific and detailed analysis of the material can be used to determine the exact nature and extent of the defect.

It will be appreciated that since the operator can manipulate the glove and can actually feel beneath his fingers for good contact of the probes with the substrate surface, he can ensure continuous and positive contact thus largely eliminating false readings and providing a rapid and highly accurate assessment of the thickness characteristics within the material.

The selected type and positioning of the probes within the pad 11 are such that the scanned volume from each probe overlaps with that of the next adjacent probe. Thus, any reduction in thickness will be detected.

In an alternative arrangement, the probes or emitters within the probes, may be arranged to scan at a angle other than 90° from the surface. In this way, less pronounced defects or internal surface "pitting" will be detected by the scan signal whereas a sharply defined defect extending substantially radially with respect to the pipe wall could be missed by a signal directed radially. Selection of the angle is determined according to the particular circumstances of the application. A further novel feature is that all the sensors are fired simultaneously thus avoiding the need for complex electronic switching arrangements and an individual monitoring gate for each sensor.

It will be seen that a scanning device made in accordance with the invention is particularly useful for an operator or inspector who must climb or descend into a large enclosed vessel, perhaps using ropes or similar equipment requiring both hands for

manoeuvring himself to a site to be inspected. Upon arrival at the site, where the operator may then make one hand free, he can apply the glove to carry out the inspection.

It will further be seen that a scanning device made in accordance with the invention avoids the use of complex and sensitive manipulative mechanical devices in order to ensure continuous and positive contact, in an environment in which such devices may be subject to damage or may become defective due to contamination.

It is not intended to limit the invention to the details described above. For example more or less than four probes may be attached to the glove, but four or five represents an array which can easily be manipulated by the gloved hand whilst ensuring a span of 100mm or more thus to cover as wide as possible an area with one sweep.

The glove may be replaced by an arrangement of elastic loops for insertion of the fingers.

In the prototype equipment produced by the applicants the following equipment was identified as being satisfactory for the required application. Each probe was a 5 MHz, 10mm twin crystal compression probe, type GB TCE 10-5. The junction box 14 was an 8-in, 2-out mini-lemo connector unit with alarm LED and cable input from the flaw detection unit with an earphone output. The flaw detection unit was a Panametrics Epoch II 2100 digital ultrasonic flaw

detector with twin lemo connectors and earphone/alarm socket.

CLAIMS

1. A scanning device adapted to produce an electrical signal representative of a physical characteristic of a substrate with which the device is placed in surface contact, the device comprising a flexible carrier, at least one sensor mounted on the carrier including means to produce an electrical signal, and means for mounting the carrier on an operator's hand such that manipulation of the hand and thus the flexible carrier may ensure positive contact between the carrier and the substrate surface.

2. A scanning device according to Claim 1, being in the form of a glove and the carrier is a flexible pad attached to and extending across the inner surfaces of the fingers, there being an array of ultrasonic sensors or probes attached to the flexible pad.

3. A scanning device according to Claim 2, wherein each said sensor or probe is connected to a junction box attached to the outer surface of the glove and including a visual or audible alarm and an electrical lead to transmit signals to a remote monitor.

4. A scanning device according to Claim 2, wherein each of said array of sensors produces a scanning beam, the sensors of each adjacent pair thereof being spaced apart such that by virtue of the width of the scanning beam a predetermined area of coverage is obtained.

5. A scanning device according to Claim 2, wherein the flexible pad has embedded therein an array of four of said ultrasonic

sensors, the sensors of each adjacent pair thereof being spaced apart such by a distance of approximately 33mm thus to provide an overall scan width of the array in the region of 100mm.

6. A scanning device according to Claim 2, wherein the ultrasonic sensors are connected individually by respective leads to a junction box the output of which is connected via a lead to a remote ultrasonic detection unit.

7. A scanning device according to Claim 6, wherein the array of ultrasonic sensors transmit signals simultaneously to the ultrasonic detection unit.

8. A scanning device according to Claim 6, wherein the junction box is attached to the glove by strapping and includes a visual alarm in the form of an LED.

9. A scanning device according to Claim 1, wherein the or each sensor contains a pair of emitters which together emit a signal adapted to pass through a the thickness of a substrate to a remote surface thereof thus to be reflected back to the sensor whereby the time period until receipt of the reflected signal provides a reading representing the thickness of the substrate beneath the sensor.

10. A scanning device according to Claim 6, wherein the ultrasonic detection unit is adapted to emit a signal to activate the visual or audible alarm on the glove.

11. A scanning device according to Claim 2, the type and positioning of the sensors on the flexible pad being selected such that the scanned volume from each sensor overlaps with that of the next adjacent sensor on the pad.

12. A scanning device according to Claim 2, wherein the sensors are arranged to scan at an angle other than 90° from the surface of the flexible pad.

13. A scanning device according to Claim 1, wherein the flexible carrier includes at an arrangement of elastic loops for insertion of the operator's fingers.

14. A scanning device according to Claim 1, wherein the or each sensor is a 5 MHz, 10mm twin crystal compression probe, the junction box is an 8-in, 2-out mini-lemo connector unit and the ultrasonic detection unit is a digital ultrasonic flow detector with twin lemo connectors.

The Patent Office

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Application No: GB 9515457.1
Claims searched: 1-14

Examiner: David Summerhayes
Date of search: 5 July 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): G1G (GEEH, GEEM), G1N (NCDC, NENX), A5R (RHEC)

Int Cl (Ed.6): G01B (17/00, 17/02), G01N (29/22, 29/24, 29/26)

Other: ONLINE: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB1571643	(YEDA)	1
X	EP0190043 A2	(BIOSONICS)	1
A	EP0173837 A2	(HERBERHOLZ) - see Fig. 1	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 2004/000128

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01N 29/10, G01N 29/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTENAL,WPI,PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5428999 A (M.FINK), 4 July 1995 (04.07.1995), whole document	1,3-13
Y		2
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Y	US 5528557 A (M.HORN), 18 June 1996 (18.06.1996), column 4, line 10 - line 29	2
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X	GB 2303704 A (E M & I (SAFETY SYSTEMS)LTD.), 26 February 1997 (26.02.1997), page 3, line 6 - page 4, line 17, figures 1,2	1,8-10
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 August 2004	14 -09- 2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Henrik Eriksson/itw Telephone No. +46 8 782 25 00

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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